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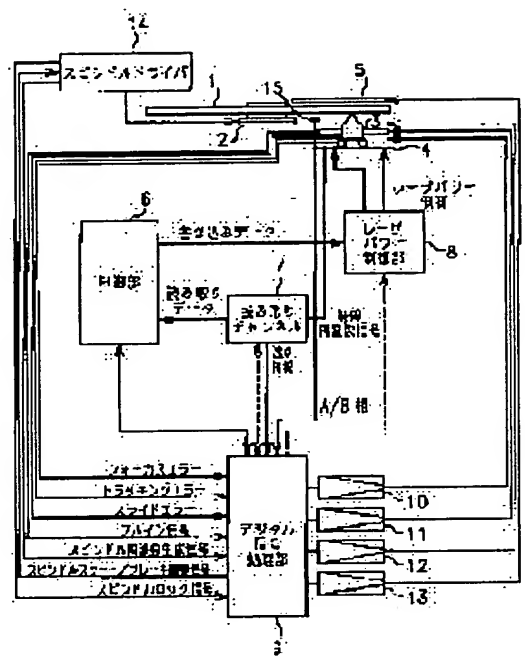
## (54) METHOD FOR CONTROLLING DISK

(57)Abstract:
PROBLEM TO BE SOLVED: To make supportable plural kinds of disk-shaped recording media by reading manufacture information recorded in a prescribed area of a recording medium and controlling recording/reproduction to/from the recording medium on the basis of the read manufacture information.
SOLUTION: A controlling part 6 recognizes the type of a magneto-optical disk 1 on the basis of identification information read from a phase encoding part of the disk 1, especially, on the basis of the manufacture information of the 16th and the 17th bytes of a phase encoding part and calibrates a read channel. After the calibration, it controls angular acceleration when a spindle motor 2 stops and performs gain control in the calibration of the read channel 7 on the basis of the manufacture information. Thus, it is unnecessitated to lower the performance of a magneto-optical disk drive to all disks 1 by adapting the performance of the magneto-optical disk drive to the disk 1 whose characteristic is inferior.



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[Scope of Claims for Patent]

[Claim 1] A disk control method for controlling the recording and reproduction of information signals stored on plural types of disk-shaped recording media, characterized by comprising a reading step for reading manufacturing information recorded in a predetermined area of a recording medium, and a control step for controlling the recording and reproduction to the recording medium on the basis of the manufacturing information read out in said reading step.

[Claim 2] The disk recording method of Claim 1, characterized in that the manufacturing information is recorded as phase-encoded information signals in the innermost perimeter of the recording media.

[Claim 3] The disk control method of Claim 1, characterized in that said control step is to determine the characteristics of the recording medium on the basis of the manufacturing information read out in said reading step, and control the recording and reproduction according to the characteristics.

[Claim 4] The disk control method of Claim 3, characterized in that the characteristics refer to the characteristics of the recording medium, which are unique to the manufacturer and is specified by the manufacturing information.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to a disk control method for controlling recording and reproduction of information signals with respect to disk-shaped recording media.

[0002]

[Description of the Related Art] Conventionally, a magneto-optical disk made by coating magneto-optical material (MO) on a disk-shaped substrate is provided as a recording medium for recording information signals, the MO material capable of magnetically writing information signals and optically reproducing the recorded information signals.

[0003] More than 30 different types of magneto-optical disks are available, including, for example, for 5.25-inch magneto-optical disks, those with 1x, 2x, 3x, 4x and 8x recording density levels; those with so-called MO, CCW (continuous composite write once), WORM (write once read many) and Lim-DOW (light intensity modulation direct drive) recording methods; and those with 2K-byte, 1K-byte, and 512-byte sector formats.

[0004] For this reason, a disk player, for example, which records and reproduces information signals on a 5.25-inch magneto-optical disk with 8x recording density, must support magneto-optical disks of other formats in order to ensure compatibility with all types of magneto-optical disks.

[0005]

[Problems to be Solved by the Invention] Each type of magneto-optical disk, however, has its own track pitch, spiral

direction, reflectance, and optimal level of laser power. Therefore, it is essential to first identify the type of magneto-optical disk in order to support plural types of magneto-optical disks of different formats.

[0006] This invention has been made in consideration of the above-mentioned circumstances, and the objective of the invention is to provide a disk control method for identifying each type of magneto-optical disk.

[0007]

[Means for Solving the Problems] In order to solve the above-mentioned problems and according to the present invention, a disk control method for controlling the recording and reproduction of information signals recorded on plural types of disk-shaped recording media includes a reading step for reading manufacturing information recorded in a predetermined area of a recording medium and a control step for controlling the recording and reproduction to the recording medium based on the manufacturing information read out in the reading step.

[0008]

[Preferred Embodiment of the Invention] An embodiment of this invention will be described in detail by referring to the accompanying drawings. Firstly, the structure of a magneto-optical disk drive that records and reproduces information signals with respect to the magneto-optical disk will be described as an embodiment of this invention.

[0009] As FIG 1 shows, the magneto-optical disk drive includes a spindle motor 2 that drives a magneto-optical disk 1 to rotate, an optical block 3 that radiates a laser beam on the magneto-optical disk 1 and receives the light returning from the magneto-optical disk 1 that has been radiated with the laser beam, an optical-block movable part 4 that supports the optical block 3 and enables the optical block 3 to move in the radial direction of the magneto-optical disk 1, and a linear encoder 15 that detects the travel of the optical block 3.

[0010] The spindle motor 2 drives the magneto-optical disk 1 to rotate through a table on which the magneto-optical disk 1 is placed. The optical block 3 includes a laser diode that radiates a laser beam on the magneto-optical disk 1, a photo detector (PD) that receives the light returning from the magneto-optical disk 1, and an object lens that collects the laser beam emitted from the laser diode and the light returning from the magneto-optical disk 1. The object lens is placed to face the magneto-optical disk 1. The optical-block movable part 4 supports the optical block 3 and allows the optical block 3 to move along the radial direction of the magneto-optical disk 1. The optical-block movable part 4 may be a sliding bearing. The linear encoder 15 detects the travel of the optical block 3 in the optical-block movable part 4 by, for example, taking advantage of magnetic interactions.

[0011] The magneto-optical disk drive also includes a reading channel 7 that receives radio-frequency (RF) signals from the optical block 3 and performs prescribed processing defined by the International Standardization Organization, a laser power controller 8 that controls the power level of the laser beam emitted from the optical block 3, a controller 6 that controls each part of the magneto-optical disk drive, and a digital signal processor (DSP) 9 for performing prescribed processing on digital signals.

[0012] The reading channel 7 receives RF signals from the optical block 3 based on signals from the digital signal processor 9 and extracts the read data and identification information from the RF signals. The reading channel 7 then sends the read data to the controller 6 and the identification information to the digital signal processor 9.

[0013] The laser power controller 8 controls the power level of the laser beam emitted from the optical block 3 based on the signals from the digital signal processor 9. In addition, the laser power controller 8 sends the write data sent from the controller 6 to the optical block 3 for writing to the magneto-optical disk 1 with the laser beam of a controlled power level.

[0014] The controller 6 controls each part of the magneto-optical disk drive. The controller 6, for example, executes prescribed processing on the data from the digital signal

processor 9 and the read data from the reading channel 7, and sends the write data to the laser power controller 8.

[0015] The digital signal processor 9 performs prescribed signal processing on the digital signals. In other words, the digital signal processor 9 performs prescribed signal processing based on identification information and prescribed signals from the reading channel, data from the controller 6, and information from linear encoder 15 on the travel of the optical block 3. Then, the digital signal processor 9 sends data to the controller 6 and signals to the reading channel 7 and laser power controller 8. In addition, digital signal processor 9 processes various driver signals. The various driver signal processing performed by the digital signal processor 9 will be discussed next.

[0016] The magneto-optical disk drive also includes a focus driver 10 for driving the object lens along the focusing axis, a tracking driver 11 for driving the object lens along the tracking axis, a slide driver 12 for sliding the optical block 3 radially over the magneto-optical disk 1, a bending magnet (BM) driver 13 for driving a bending magnet 5, and a spindle driver 14 for driving the spindle motor 2.

[0017] The focus driver 10 drives the object lens along the focus axis based on a control signal from the digital signal processor 9 to ensure that the laser beam emitted from the optical block 3 remains in focus on the signal recording

surface of the magneto-optical disk 1. The digital signal processor 9 generates the control signal to the focus driver 10 based on a focus error signal from the optical block 3.

[0018] The tracking driver 11 drives the object lens across recording tracks based on a control signal from the digital signal processor 9 to ensure that the laser beam emitted from the optical block 3 remains in focus on a recording track formed on the signal recording surface of the magneto-optical disk 1. The digital signal processor 9 generates the control signal to the tracking driver 11 based on the tracking error signal from the optical block 3.

[0019] The slide driver 12 moves the optical block 3 in a radial direction over the Magneto-optical disk 1 based on a control signal from the digital signal processor 9. The digital signal processor 9 generates the control signal to the slide driver 12 based on a slide signal from the optical block 3. The motion of the optical block 3 in a radial direction over the magneto-optical disk 1, driven by the slide driver, might be called rough movements, because the optical block 3 travels a much larger distance compared with minute movements of the object lens driven by the tracking driver 11.

[0020] The bending magnet driver 13 drives the bending magnet 5 based on a control signal from the digital signal processor 9.

[0021] The spindle driver 14 drives the spindle motor 2 to rotate in accordance with a spindle start/brake control signal from the digital signal processor 9. The digital signal processor 9 generates the spindle start/brake signal based on a spindle frequency generator (SPFG) signal and a spindle lock (SPLK) signal from the spindle driver 14. The spindle start/brake signal, spindle frequency generator signal, and spindle lock signal will be discussed later in further detail.

[0022] Operation of the magneto-optical disk drive will be discussed next. Firstly, recording and reproduction of information signals with respect to the magneto-optical disk 1 will be discussed.

[0023] When reproducing information signals from the magneto-optical disk 1, the optical block 3 radiates a laser beam on the magneto-optical disk 1 and receives the returning beam. The information signals are reproduced from the returning beam by taking advantage of the Kerr effect. When linearly polarized light is incident on a vertically magnetized film, the Kerr effect causes the plane of polarization to be rotated in either the plus or the minus direction according to the direction of magnetization in the film.

[0024] In other words, as FIG 2 shows, one binary information signal with level "1" is represented as downward-facing magnetization, and the other with level "0" is represented as the upward-facing magnetization in a vertically magnetized film

1a on the signal recording surface of the magneto-optical disk 1. Say that these signals would be expressed as M = 1 and M = 0. Because of the Kerr effect, M = 1 and M = 0 correspond to polarization angles of $+\theta k$ and $-\theta k$, respectively. The optical block 3 passes the returning light from the magneto-optical disk 1 through an analyzer 31, which only allows light linearly polarized along a prescribed absorption axis to pass through, to convert the beam into optical-intensity signals. Then, the optical block 3 converts the optical intensity signals into electrical signals using a photo diode 32. FIG 3a and FIG 3b show the intensity of laser beam before and after passing through the analyzer 31. In FIG 3b, high level of optical intensity corresponds to "1," and low level corresponds to "0." The read channel 7 converts the RF signals thus obtained into digital signals and sends the read data to the controller 6.

[0025] When erasing the data signals recorded on the magneto-optical disk 1, the controller 6 controls the bending magnet driver 13 to drive the bending magnet 5 through the digital signal processor 9 to apply an external magnetic field on the magneto-optical disk 1. The upper part of FIG 1 would be the S pole and the lower part would be the N pole. Next, the sliding driver 12 and the tracking driver 11 move the optical block 3 to a required position along the radius of the Magneto-optical disk 1. As FIG 4 shows, the laser beam emitted from the optical block 3 and focused on the signal recording surface of

the magneto-optical disk 1 through the object lens 33 of the optical block 3 is switched to an erase output and radiated continuously so that the external magnetic field caused by the bending magnet 5 will magnetize the entire surface of the magneto-optical disk 1 in one direction.

[0026] When recording information signals on the magneto-optical disk 1, a laser beam is radiated after the information signals have been erased in a manner as discussed above. As FIG 5 shows, only the pits into which information signals are to be recorded are radiated with the laser beam on the magneto-optical disk 1, from which the information signals have been erased by magnetizing the entire surface with the bending magnet. Because the parts of the magneto-optical disk 1 that have been radiated with the laser beam are heated above the Curie point to cause ferromagnetic-paramagnetic transition, these parts are magnetized to the polarity of the external magnetic field. During this process, the laser power controller 8 drives the laser diode, which is inside the optical block 3 and emits the laser beam, based on write data from the controller 6.

[0027] When recording and reproducing information signals with respect to the magneto-optical disk 1, the focus driver 10 controls the laser beam from the optical block 3 to focus the laser beam on the signal recording surface of the magneto-optical disk 1, rotated by the spindle motor 2. In actuality,

the digital signal processor 9 performs the control operation in such a way that the focus error signal from the photo detector in the optical block 3 will be always kept at zero. Ideally, the point at which the focus error signal is 0 should be identical to the point at which signals from the magneto-optical disk 1 can be obtained most efficiently, that is, at which the amplitude of the RF signal becomes the maximum value. However, in practice, these two points are not identical and are off from each other. The difference in the two points is called a focus bias.

[0028] The tracking driver 11 controls the laser beam from the optical block 3 to follow the recording track on the signal recording surface of the magneto-optical disk 1. A groove formed on the magneto-optical disk 1 may be used as a recording track. In actuality, the digital signal processor 9 performs the control operation in such a way that the tracking error signal output from the photo detector in the optical block 3 will always be at zero. Like the focus bias, there is a so-called tracking bias.

[0029] The slide driver 12 performs control operation in such a way that a bias of the object lens off the center along the track direction, detected by a midpoint sensor in the optical block 3, will remain at 0. In actuality, the digital signal processor 9 performs the control operation in such a way that

the slide error signal output from the midpoint sensor in the optical block 3 will remain at zero.

[0030] Through the three different driver functions discussed above, the laser beam can stay in focus along the track on the rotating magneto-optical disk 1. In addition, a pull-in signal of the intensity sum is used for determining whether the photo diode is receiving adequate amounts of light.

[0031] Parts related to the spindle motor 2 will be discussed next. The spindle motor 2 is driven by the spindle driver 14. The spindle driver 14 starts rotating in response to the spindle start/brake control signal from the digital signal processor 9 and outputs a spindle lock signal to the digital signal processor 9 when a prescribed rotating speed is achieved. The polarity of the spindle start/brake control signal is reversed to stop the spindle motor 2. The spindle driver 14 generates a spindle frequency-generating signal for outputting four rectangular waves for each rotation of the spindle motor. The digital signal processor 9 is able to determine the approximate rotating speed based on the time-width of the spindle frequency generator signals. A decision on whether to stop the spindle motor is made when the spindle frequency generator signal time-width exceeds a prescribed threshold.

[0032] The linear encoder 15 is attached to a fixed part of the spindle motor side in the area where the optical block 3 can be moved in the optical moving block 4. In the discussion

that ensues, the spindle motor side of the area in which the optical moving block can move will be called the inner perimeter side of the magneto-optical disk 1 or simply the inner perimeter side. A linear scale is attached in parallel to the linear encoder 15 on a coil of a voice coil motor (VCM) of the optical moving block 4 of the optical block 3. As a result, when the optical block 3 moves on the inner side with respect to the optical moving block 4, rectangular waves that are 90° out of phase with each other are output from phase A and phase B of the linear encoder 15.

[0033] The digital signal processor 9 can check the number of waves and the phases of the signals from the linear encoder 15 to determine the direction and amount of the travel of the optical block 3. Similarly, the digital signal processor 9 is able to stop the optical block 3 at a prescribed location. For example, it is possible to stop the optical block 3 in an area of a phase-encoded part (PEP) of control tracks where identification information for the magneto-optical disk 1 is recorded.

[0034] Disk information, such as the type and sector, are recorded with pre-pit signals into the phase-encoded part of the control tracks. Usually, the drive identifies the type of disk by reading the PEP information on startup to change the internal drive settings and the like.

[0035] The area of the phase-encoded part of the control tracks looks like a bar code and is written in a format called a phase-encoding (PE) format. The phase-encoded area is located in the control track in the innermost perimeter of the medium. The phase-encoded area has the same width and is at the same distance from the center of the Magneto-optical disk 1, no matter what is the type of the magneto-optical disk 1. Therefore, the magneto-optical disk drive can determine the type of magneto-optical disk 1 by positioning the optical block 3 in this area, detecting the changes in RF signals, and decoding the identification signal recorded in the phase-encoded part. In other words, it is possible to determine the type of magneto-optical disk 1 from the identification information in the phase-encoded part, even when the track pitch on the magneto-optical disk 1 is unknown.

[0036] An example of the control track zone format will be explained next by referring to an International Organization for Standardization (ISO) standard. Information contained in the phase-encoded part provides general identification information on the magneto-optical disk 1. In other words, the phase-encoded part includes information for identifying the type of disk, error correction code (ECC), tracking method and the like.

[0037] The phase-encoded part must not include servo information. All kinds of information must be recorded in

advance by phase-encoded modulation. All track marks in this zone must be aligned along the radial direction, allowing information from this zone to return to its original state without having the driver establish tracking in the radial direction. Read power at the phase-encoding part must not exceed 0.65 mW.

[0038] As FIG 6 shows, in order to record into the phase-encoded part, 561 to 567 phase-encoded-part channel bit cells are required per physical track. The length of the phase-encoded-part channel bit cells must be a length of 656 channel bits +/- 1 channel bit. Information is recorded into the PEP channel bit by writing a mark to either the first half or the second half of the cell.

[0039] Nominally a mark must have a length of 2 phase-encoded-part channels and must be isolated from an adjacent mark by a space comparable to 2 phase-encoded-part channel bits. "0" is expressed as a change from a mark to a space at the center of a cell, while "1" is expressed as a change from a space to a mark at the center.

[0040] As far as PEP recording track formatting is concerned, each physical track in the phase-encoded part must include at least three sectors. Numbers in FIG 7 show the counts of phase-encoded-part bits in each field. Gaps between sectors are unrecorded areas and have lengths comparable to 10 to 12 phase-encoded-part bit cells.

[0041] As FIG 8 shows, as far as sector formatting is concerned, each sector of the 177 phase-encoded-part bit has the following structure. A preamble field is composed of sixteen 0 bits. A sync field is composed of a single 1 bit. A sector count field is composed of 8 bits that specify sector counts 0 to 2 in a binary manner. A data field is composed of eighteen 8-bit bytes from 0 to 17. FIG 9 shows the structure of the phase-encoded-part format that includes these fields. Each byte of the phase-encoded part is specified as described next.

[0042] The 7th bit of the 0th byte is set at 0 to show a method of continuous servo tracking. The $6^{th}$ through $4^{th}$ bits are set at 110 for specifying logic ZCAV. It is prohibited to set these bits in any other way. The third bit is set at 0. The second through $0^{th}$ bits are set at 010 to show RLM (1,7) mark edge modulation. It is prohibited to set these bits in any other way.

[0043] The $7^{th}$ bit of the first byte is set at 0. The $6^{th}$ to $4^{th}$ bits specify error correction encoding. Setting of these bits as 000 means a Reed Solomon LDC of 16° and 10 interleaves. Setting as 001 means a Reed Solomon LDC of 16° and 5 interleaves. Setting as 010 means a Reed Solomon LDC of 16° and 20 interleaves. It is prohibited to set these bits in any other way. The third bit is set at 0. The second through $0^{th}$ bits specify the power number n of w in the following equation

in a binary manner, namely n of 256 x $2^n$. This equation represents a user byte for each sector. Values for n, other than 1, 2 or 3, are prohibited.

[0044] The second byte describes the number of sectors in each logic track in a binary manner.

[0045] The third byte is used by the manufacturer for specifying the reflectance R of a reference line of the disk, which is normally measured at a wavelength of 685 nm. It is specified by a number n, such as in n = 100R.

[0046] The $4^{th}$ byte shows that the recorded data are in the user zone groove and shows the signal amplitude of the mark recorded in advance. This byte is set at 1 when recording into the $7^{th}$ bit groove. The absolute value for the signal amplitude is expressed by a number between -15 and -33 (tentative), as in n = -50 (lsm/ltop). lsm is a signal from a sector mark of channel 1, and ltop is a signal from an unmarked user zone that is not a groove. The $6^{th}$ through $0^{th}$ bits show a number n. Bit 6 is set at 1 to show that this number is a negative number. Bits 5 through 0 show 2's complements. Recording proceeds from the most significant bit to the least significant bit.

[0047] The $5^{th}$ byte specifies 10 times the capacity of an optical disk cartridge (ODC) in gigabytes (one significant figure on the right-hand side of the decimal point). According to this international standard, this byte would be set at (34) to show a capacity of 5.2 gigabytes.

[0048] The $6^{th}$ byte specifies a number n in binary to represent 20 times the maximum read power expressed in milliwatts. This maximum read power makes it possible to read an SEP zone at a rotating frequency of 50 hertz and a wavelength of 685 nm. The number n lies between 30 and 40.

[0049] The $7^{th}$ byte is set as follows: 0010 0000 for R/W (rewritable), 0000 0000 for O-ROM (optical read-only memory), 1010 0000 for P-ROM (partial read-only memory), 0001 0001 for WO (write once), 0110 0000 for DOW (direct overwrite), 1110 0000 for P-DOW (partial ROM direct overwrite), and 0001 0011 for WO-DOW (write once direct overwrite). It is prohibited to set this byte to any values expect for those listed here.

[0050] The $8^{th}$ byte specifies the most significant byte (MSB) that comes after the logical track number at which an outer control track SFP (standard formatted part of control tracks) zone starts. This byte is set at (FA), (F9), (F9) to show track numbers -1 530/-1 765/ -1 656. () represents hexadecimal notation.

[0051] The $9^{th}$ byte specifies the least significant byte for the logical track number at which the outer control track SFP zone starts. This byte is set at (06), (1B),(88) to show logical track numbers -1 530/-1 765/ -1 656.

[0052] The $10^{th}$ byte specifies the most significant byte that comes after the logical track number at which an inner control

track SFP zone starts. This byte is set at (CA) or (23) or (FE) to show track numbers 183 014/140 145/130 795.

[0053] The 11$^{th}$ byte specifies the least significant byte for the logical track number at which the inner control track SFP zone starts. This byte is set at (E6), (71), (EB) to show track numbers 183 014/140 145/130 795.

[0054] The 12$^{th}$ byte specifies 100 times the track pitch expressed in micrometers ( m). It is set at (55) to represent a track pitch of 0.85  m.

[0055] The 13$^{th}$ byte is set at (FF) and is ignored when switching.

[0056] The 14$^{th}$ byte specifies the most significant byte of the logical track number at which the outer control track SFP zone starts. This byte is set at (FF), (FF), (FF) to show logical track numbers -1 530/-1 765/-1 656.

[0057] The 15$^{th}$ byte specifies the most significant bit of the logical track number at which the inner control track SFP zone starts. This byte is set at (02), (02), (01) to show logical track numbers 183 014/140 145/130 795.

[0058] Manufacturing information on the magneto-optical disk 1 is recorded into these bytes. For example, as FIG 1 shows, "AB" is written for manufacturing information "ABC", "EF" for manufacturing information "DEF", "GH" for manufacturing information "GHI", "JL" for manufacturing information "JKL", "MM" for manufacturing information "MNO", "QR" for

manufacturing information "PQR", and "TU" for manufacturing information "STU". Therefore, it is possible to get the manufacturing information for the magneto-optical disk 1 by reading the 16$^{th}$ byte and the 17$^{th}$ byte. The magneto-optical disk drive controls the recording and reproduction with respect to the magneto-optical disk 1 based on the manufacturing information according to the characteristics of the magneto-optical disk 1 unique to each manufacturer.

[0059] Next, the recording and reproduction operations of the magneto-optical disk drive based on the manufacturing information will be discussed.

[0060] The controller 6 identifies the type of magneto-optical disk 1 based on the identification signals read from the phase-encoded part of the magneto-optical disk, specifically the manufacturing information in the 16$^{th}$ byte and the 17$^{th}$ byte of the phase-encoded part.

[0061] In other words, areas of different reflectances appear alternately in the area where the phase-encoded part is recorded on the magneto-optical disk 1, and bring changes in amplitude of the RF signals. The reading channel 7 converts these changes to digital signals with two levels corresponding to high or low values, and inputs the signals to a pulse width counter (PWC) of the digital signal processor 9. The digital signal processor 9 decides the length of time over which the digital signals remain at the high level or at the low level,

and decodes the measurement results to obtain 18-byte identification information for the magneto-optical disk 1. The controller 6 identifies the type of Magneto-optical disk 1 based on the identification information.

[0062] After identifying the type of magneto-optical disk 1, the controller 6 performs calibration of the reading channel 9. Specifically, the calibration stated here is to adjust the gain to such a value that the amplitude becomes suitable for the reading channel 9 to digital-convert the RF signals obtained from the magneto-optical disk 1 while canceling electrical offsets in the reading channel 9 itself.

[0063] In general, the amplitude of an RF signal can vary significantly depending on the manufacturing information, such as different-generation recording densities of the magneto-optical disk 1, which can range from 1x to 2x, 3x, 4x or 8x. Variations in manufacturing the reading channel 7 can also result in significant variations in the electrical offsets. Information stored on the Magneto-optical disk 1 cannot be read accurately without adjusting these values correctly. The reading channel 7 in this embodiment allows individual adjustment in the gain and offset between RF signals of an address identifier ID and RF signals of a data part.

[0064] After the calibration discussed above, the controller 6 of the magneto-optical disk drive performs control operations, based on the manufacturing information, on the angular

acceleration for stopping the spindle motor and the gain during the reading channel calibration.

[0065] Control of the angular acceleration for stopping the spindle motor 2 is to adjust angular acceleration of the spindle motor 2 of the magneto-optical disk drive based on the manufacturing information written in the 16th byte and the 17th byte of the phase-encoded-part information on the magneto-optical disk 1. This process is carried out under the control of the controller 6 of the magneto-optical disk drive.

[0066] Figure 11 shows a flowchart for the process of controlling the angular acceleration. In the first step S11, a determination is made on whether the magneto-optical disk 1 loaded into the magneto-optical disk drive is such an unsophisticated disk that it will slip, an abnormal condition will occur, or it will cause damages to the hub when stopped with a normal angular acceleration. This determination is made by reading the manufacturing information written in the phase-encoded part of the magneto-optical disk 1 and determining whether the manufacturing information is "XX" or not. If the manufacturing information is "XX," the result of this step will be "YES," regarding the magneto-optical disk 1 as having inferior characteristics. Then the procedure goes to step S12. If the manufacturing information is not "XX," the magneto-optical disk 1 does not have inferior characteristics, and the result is "NO." Then the procedure goes to step S15.

[0067] In step S12, a determination is made on whether the magneto-optical disk 1 is rotating at high speed. If the magneto-optical disk 1 is rotating at high speed, the answer is "YES," and step S13 follows. If the magneto-optical disk 1 is not rotating at high speed, the answer is "NO," and step S15 follows.

[0068] In step S13, the clock frequency for the spindle driver 2 is switched to a clock frequency for lower speed. As a result, the spindle driver 2 rotates the magneto-optical disk 1 at low speed.

[0069] In step S14, a determination is made on whether the magneto-optical disk 1 is rotating at low speed as a result of the change in the clock frequency in step S13. If the magneto-optical disk 1 is rotating at low speed, the result is "YES," and step 15 follows. If the magneto-optical disk 1 is not rotating at low speed, the result is "NO," and the procedure returns to step S14.

[0070] In step S15, the angular speed of the spindle motor 2, which drives the magneto-optical disk 1 to rotate, is gradually lowered. In step S16, a determination is made on whether the spindle motor 2 has stopped. If the spindle motor 2 has stopped, the result is "YES," and this flow ends. If the spindle motor 2 has not stopped, the result is "NO," and the procedure returns to step S16.

[0071] By following these steps, the angular acceleration at the time of stopping the spindle motor 2 is adjusted based on the manufacturing information stored in the phase-encoded part of the magneto-optical disk 1.

[0072] Some magneto-optical disks 1 with specific manufacturing information can be inferior in hub mechanical strength and magnetic adhesion. By adjusting the angular acceleration based on the manufacturing information as explained above, it is possible to appropriately handle the magneto-optical disk 1 with the specific manufacturing information that can cause a slip, an abnormal condition, or damage to the hub when the spindle motor 2 stopped with a normal angular acceleration.

[0073] Taking the countermeasure described above to adjust performance of the magneto-optical disk drive with respect to the magneto-optical disk 1 of inferior characteristics, it is possible to avoid a compromise in the performance of the magneto-optical disk drive with respect to all magneto-optical disks 1. In other words, it will no longer be necessary to slow down the stopping of all the magneto-optical disks 1 including the magneto-optical disk 1 of inferior characteristics. This problem was previously unavoidable, mainly with the 5.25-inch magneto-optical disk drives used for juke boxes.

[0074] The next discussion is on gain control during calibration of the reading channel 7 based on the manufacturing information written in the phase-encoded part of the magneto-optical disk 1. Gain control of the reading channel 7 is performed under the control of the controller 6 in accordance with the manufacturing information in the 16th byte and the 17th byte of the magneto-optical disk 1.

[0075] FIG 12 shows a flowchart for the gain control process of the reading channel 7. In the first step S21, a determination is made on whether the manufacturing information written in the 16th byte and the 17th byte of the phase-encoded part of the magneto-optical disk 1 is "YY." If the manufacturing information is "YY," the result is "YES" and step S22 follows. If the manufacturing data is not "YY," then the result is "NO" and step S23 follows.

[0076] In step S23, the target value for the calibration of the reading channel 7 is increased by 6dB. In step S24, the reading channel 7 is structured.

[0077] The control process for the calibration of the reading channel 7 addresses situations in which a pre-pit record with address information prerecorded therein is inappropriate. In other words, even when address information is recorded on the magneto-optical disk 1 as pre-pits (with pits and projections), it may be difficult to read the correct address information under normal gain adjustment, if the pre-pits are not cut

appropriately. In the steps explained above, such a disk is identified using the "YY" manufacturing information, and the target value for the reading channel 7 calibration is increased by 6dB to address the problem.

[0078] By controlling the calibration of reading channel 7 as described above and by reading the address information recorded in pre-pits with an appropriate gain of the reading channel 7 for each magneto-optical disk 1, it is possible to eliminate the need to adjust the magneto-optical disk drive to magneto-optical disks 1 on which address information is recorded with inappropriate cutting pitch or intervals.

[0079] As discussed above, this embodiment is to perform control optimized for characteristics of the magneto-optical disk 1 based on manufacturing information written in the 16$^{th}$ byte and the 17$^{th}$ byte in the phase-encoded part of the magneto-optical disk 1.

[0080] Although this embodiment took the manufacturing information as an example of the identification information for identifying the disk, this invention is not limited to the manufacturing information. In addition, this embodiment illustrated the phase-encoded part as an example of the specific area of the magneto-optical disk 1, but the area for recording the identification information is not limited to the phase-encoded part.

[0081]

[Effects of the Invention] This invention facilitates identification of the type of magneto-optical disk by reading the identification information recorded on the magneto-optical disk and recording and reproduction operations with respect to the magneto-optical disk under conditions optimized for the magneto-optical disk. Therefore, this invention eliminates the need to adjust a standard for processing all magneto-optical disks based on some magneto-optical disks with inferior characteristics and thus the need to lower the performance. This invention also makes it possible to avoid failures because it facilitates processing optimized for each magneto-optical disk even when some magneto-optical disks have inferior characteristics.

[Brief Description of the Diagrams]

[FIG 1] It is a block diagram showing the structure of a magneto-optical disk drive to which an embodiment of this invention is applied.

[FIG 2] It is an illustration for explaining how information signals are reproduced from a magneto-optical disk using the Kerr effect.

[FIG 3] It is a diagram showing optical intensity before and after an optical analyzer.

[FIG 4] It is an illustration for explaining how information signals from the magneto-optical disk are erased.

[FIG 5] It is an illustration for explaining how data signals are recorded on the magneto-optical disk.

[FIG 6] It is a diagram showing information signals in a phase-encoded part.

]FIG 7] It is a diagram showing one physical track of the phase-encoded part.

[FIG 8] It is a diagram showing the structure of one sector of the phase-encoded part.

[FIG 9] It is a diagram showing the structure of the phase-encoded part.

[FIG 10] It is a diagram showing manufacturing information recorded in the 16th byte and the 17th byte of the phase-encoded part.

[FIG 11] It is a flowchart showing a sequence of steps for controlling the rotation of a spindle driver.

[FIG 12] It is a flowchart showing a sequence of steps for controlling the gain of a reading channel.

[Reference Numbers]

1. Magneto-optical disk
3. Optical block
6. Controller
7. Reading channel
9. Digital signal processor

Blocks:

14. Spindle Driver

6. Controller

7. Reading Channel

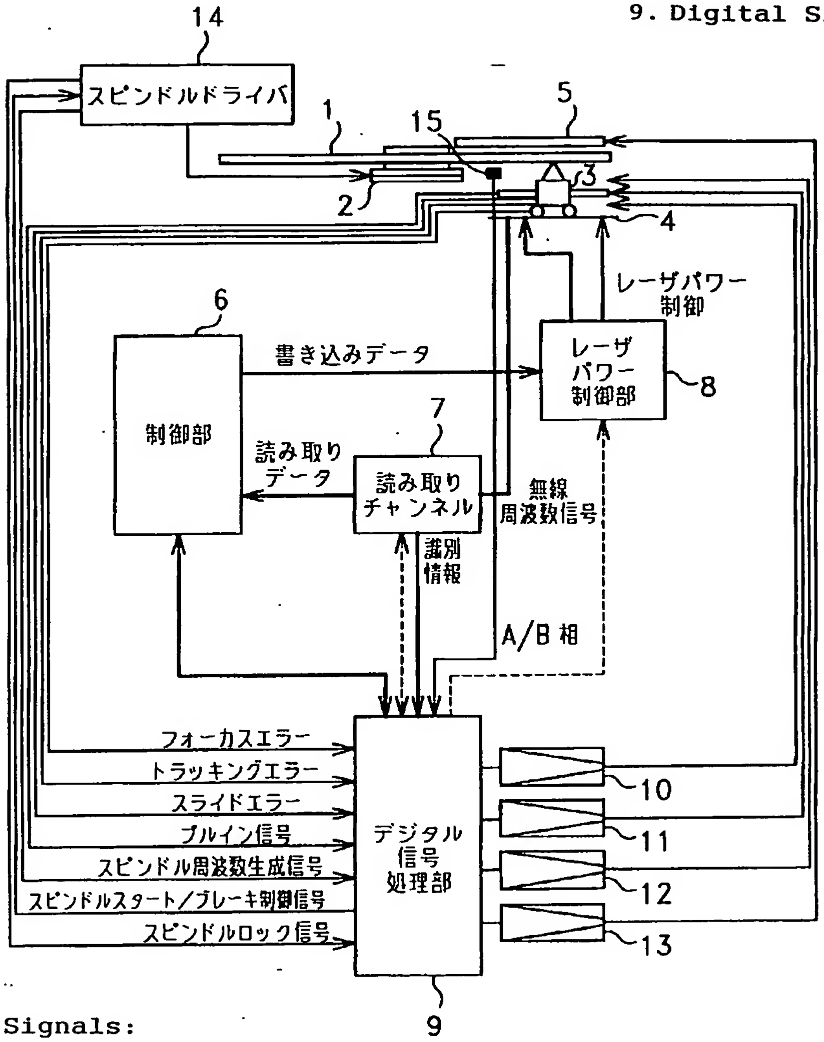
8. Laser Power Controller

9. Digital Signal Processor



【書類名】 図面

【図1】




Signals:

6 To 8: Write Data

7 To 6: Read Data

7 To 9: Identification Information

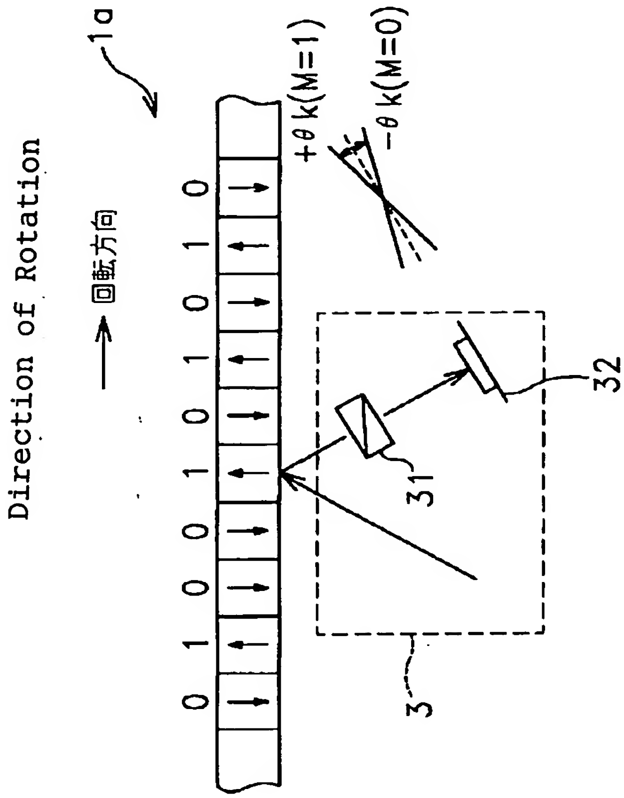
15 To 9: A/B Phase

9 To 8: RF Signals

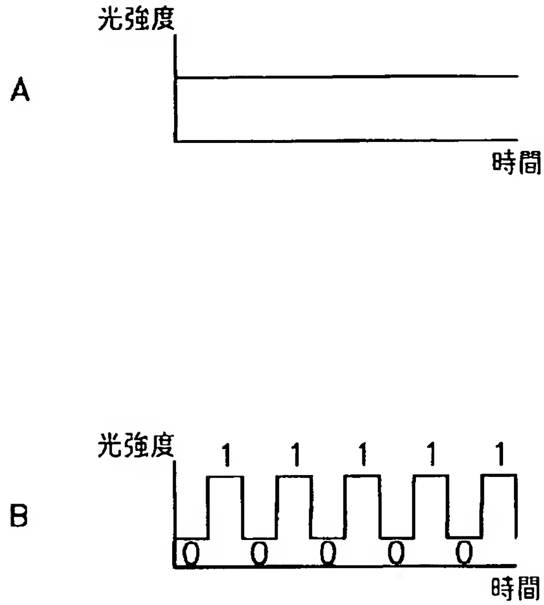
8 To 4: Laser Power Control

Into 9 (Top To Bottom): Focus Error, Tracking Error, Slide Error, Pull-In Signals, Spindle Frequency Generating Signal, Spindle Start/Brake Signal, Spindle Lock Signal

【図2】



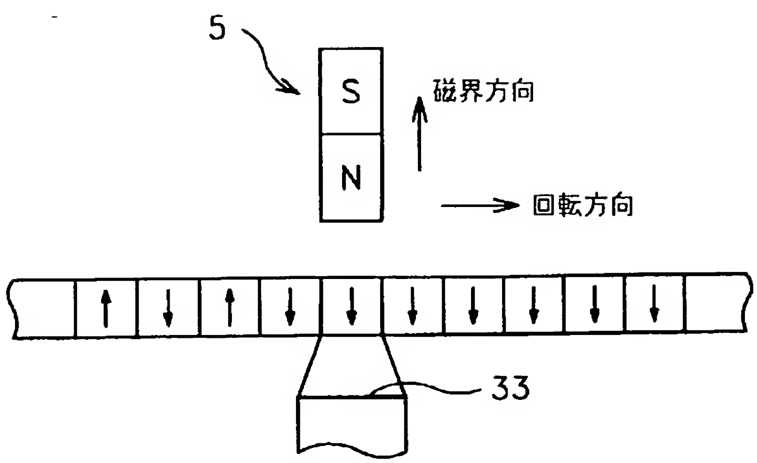
【図3】




Optical Intensity (Y-Axis)

Time (X-Axis)

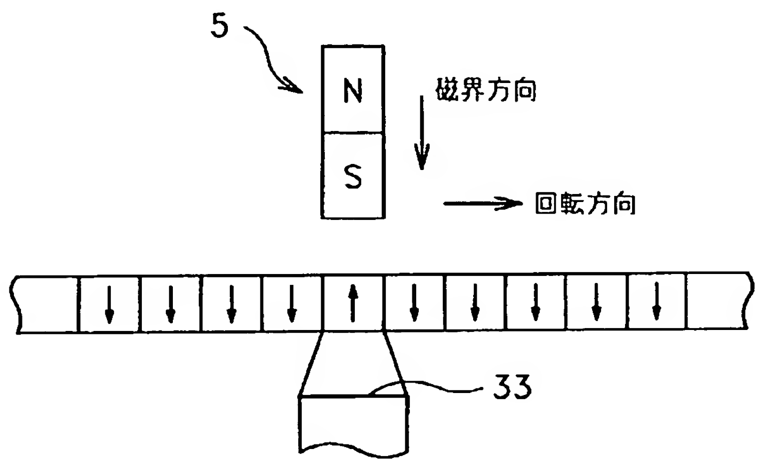
【図4】




Magnetic Field (Up Arrow)

Direction of Rotation (Right Arrow)

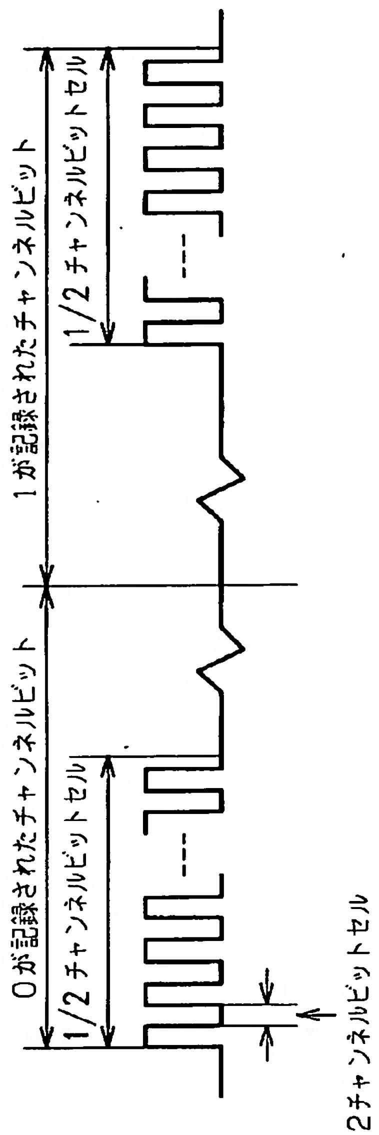
【図5】




Magnetic Field (Down Arrow)

Direction of Rotation (Right Arrow)

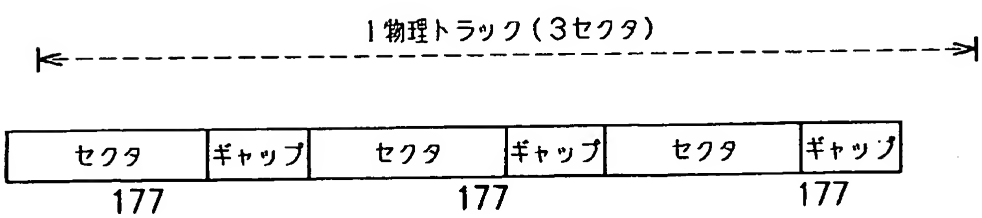
【図6】




Line 1: Channel Bit with Value "0," Channel Bit with Value "1"

Line 2: ½ Channel Bit Cell, ½ Channel Bit Cell

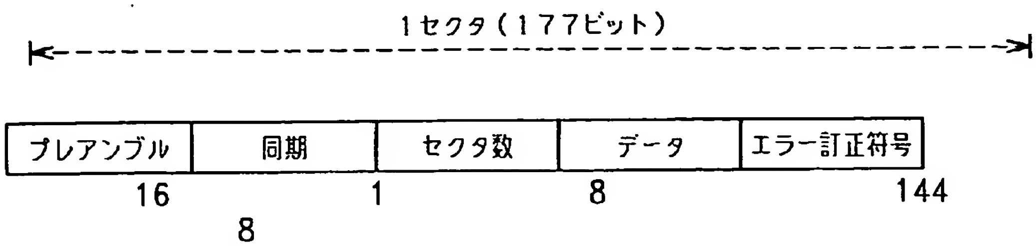
【図7】




Line 1: One Physical Track (3 Sectors)

Line 2: Sector, Gap, Sector, Gap, Sector, Gap

【図8】




Line 1: One Sector (177 Bits)

Line 2: Preamble, Sync, Sector Count, Data, Error Correction Encoding

【図9】

| バイト＼ビット | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | フォーマット | 論理ZCAV | | | 0 | 変調符号 | | |
| 1 | 0 | ECC | | | 0 | ユーザバイト数 | | |
| 2 | 各論理トラックのセクタ数 | | | | | | | |
| 3 | 685nmでの基準線反射 | | | | | | | |
| 4 | 0 | あらかじめフォーマットされたデータの振幅と極性 | | | | | | |
| 5 | ODC容量 | | | | | | | |
| 6 | 50Hzおよび685nmでのSFPゾーンの最大読み取りパワー | | | | | | | |
| 7 | ディスク型 | | | | | | | |
| 8 | 外側SFPゾーンの開始トラック、論理トラック番号の次に最上位バイト | | | | | | | |
| 9 | 外側SFPゾーンの開始トラック、論理トラック番号の最下位バイト | | | | | | | |
| 10 | 内側SFPゾーンの開始トラック、論理トラック番号の次に最上位バイト | | | | | | | |
| 11 | 内側SFPゾーンの開始トラック、論理トラック番号の最下位バイト | | | | | | | |
| 12 | トラックピッチ | | | | | | | |
| 13 | (FF) | | | | | | | |
| 14 | 外側SFPゾーンの開始トラック、論理トラック番号の最上位バイト | | | | | | | |
| 15 | 内側SFPゾーンの開始トラック、論理トラック番号の最下位バイト | | | | | | | |
| 16 | 製造情報1 | | | | | | | |
| 17 | 製造情報2 | | | | | | | |

Figure 9

(Line#: Contents)

Header: Byte \ Bit

0: Format, Logic ZCAV, Modulation Encoding

1: User Byte Count

2: Sector Count On Each Logical Track

3: Reference-line Reflection at 685 nm

4: Amplitude and Polarity of Data Formatted in Advance

5: ODC Capacity

6: SFP Zone Maximum Read Power at 50 Hz and 684 nm

7: Type of Disk

8: Control Track of Outer SFP Zone, Most Significant Byte That Comes After Logical Track Number

9: Start Track of Outer SFP Zone, Least Significant Byte for Logical Track Number

10: Start Track of Inner SFP Zone, Most Significant Byte That Comes After Logical Track Number

11: Start Track of Inner SFP Zone, Least Significant Byte for Logical Track Number

12: Track Pitch

13: (FF)

14: Start Track of Outer SFP Zone, Most Significant Byte for Logical Track Number

15: Start Track of Inner SFP Zone, Least Significant Byte for Logical Track Number

16: Manufacturing Information 1

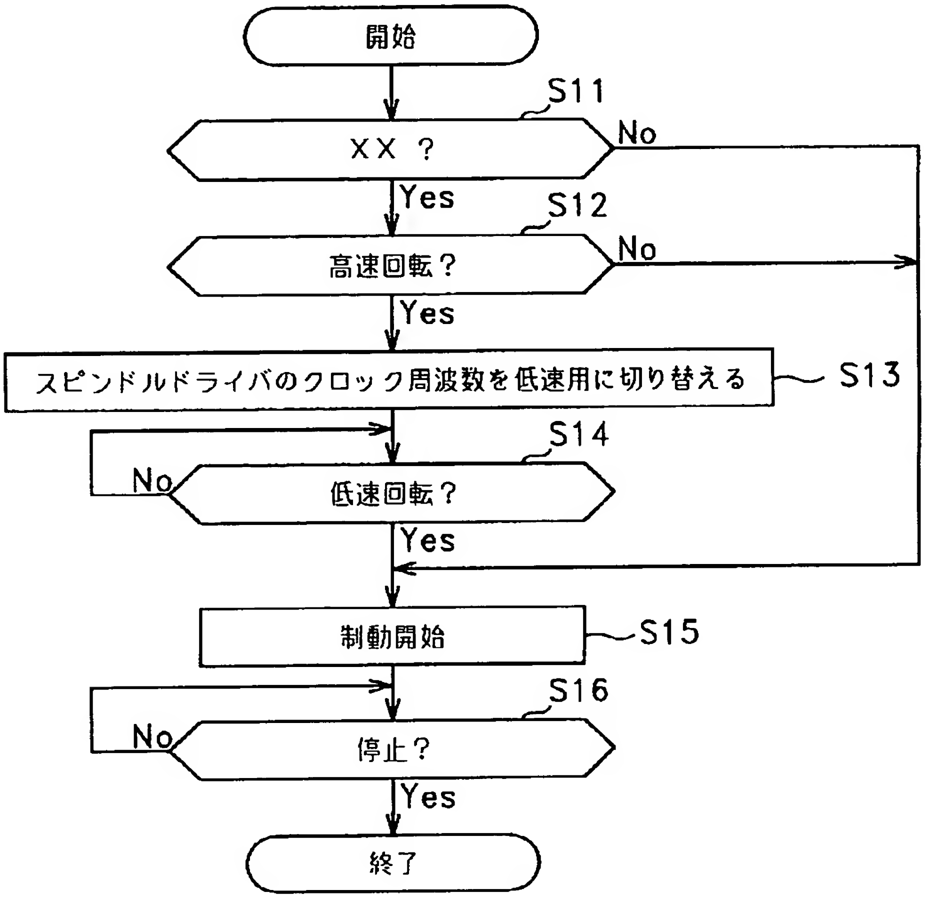
17: Manufacturing Information 2

【図１０】

| 製造情報 | 第１６バイト | 第１７バイト |
|---|---|---|
| ABC | A | B |
| DEF | E | F |
| GHI | G | H |
| JKL | J | L |
| MNO | M | M |
| PQR | Q | R |
| STU | T | U |

(Header) Manufacturing Information, $16^{th}$ Byte, $17^{th}$ Byte

【図１１】




Start

XX?

Rotating at High Speed?

Change Spindle Driver Clock Frequency to One for Lower Speed

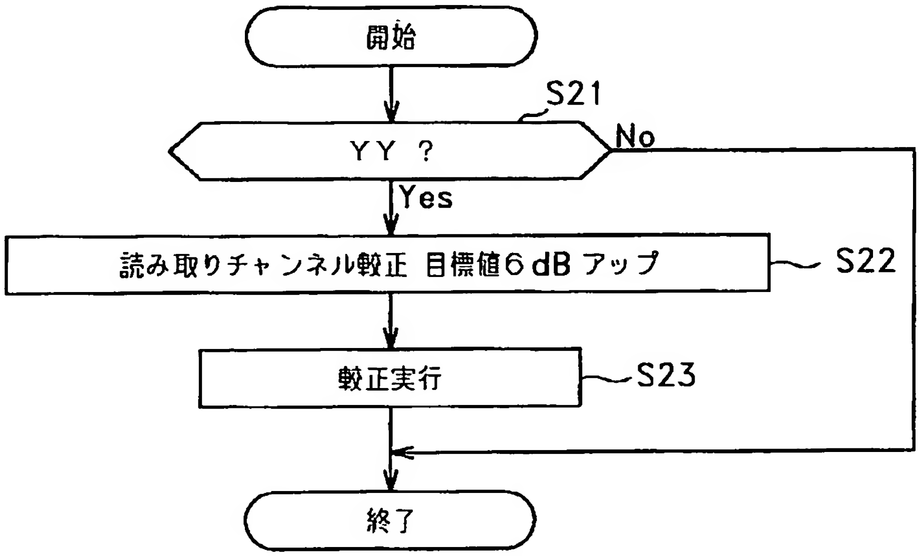
Rotating At Low Speed?

Start Braking

Stop?

End

【図１２】




Start

YY?

Calibration of Reading Channel with a 6dB Increase in

Target Value

Execute Calibration

End